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CONTROLLING COMMON SCAB OF THE POTATO ON LONG ISLAND BY THE ADDITION OF MERCURY COMPOUNDS TO THE FERTILIZER MIXTURE AND THE RELATION OF SOIL REACTION TO THE TREATMENT

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ABSTRACT

TESTS were made at the Long Island Vegetable Research Farm, Riverhead, N. Y., of the addition of mercury compounds to the fertilizer mixture for the control of potato scab. Each of these materials was used at the rate of 2, 4, and 6 pounds per ton of fertilizer. One ton of fertilizer per acre was applied.

The 4-pound rate was the most effective and each of the materials gave a significant decrease in the amount of scab on soils having a reaction of pH 5.50 or lower. The results are given on the basis of classified scab groups and also the relation of these scab groups to certain pH ranges.

High amounts of either of the mercury compounds may result in decreased yields.

Soil reaction plays an important part in the incidence of potato scab, the scab increasing as the pH readings increase.

The results presented in this paper may be applicable only to Long Island conditions and possibly to certain soil types.

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INTRODUCTION

COMMON SCAB of the potato is found to a greater or less extent wherever potatoes are grown and various methods of control have been advocated from time to time. The importance of soil reaction in relation to the disease has been demonstrated by many workers and in the intensive potato growing areas of Long Island the growers pay considerable attention to the soil reaction since they fully realize the danger in having this too high. In spite of every effort to keep their potato soils below the danger point, growers are constantly reporting the presence of scab at soil reactions of pH 5.2 or below. This condition, together with reports by Martin (5)[1] on results obtained in New Jersey by the use of mercury compounds in the fertilizer, led to the work presented in this paper. Under certain conditions Martin reports a considerable reduction in scab due to the treatment while under other conditions the treatment was not satisfactory.

Taylor (9) reports that the use of mercury compounds in the fertilizer mixture in western New York resulted in significant increases in potato scab on soils having values of at least pH 6.00. Again Taylor and Blodgett (10) report that further work has confirmed their findings that mercury compounds added to the soil increase potato scab under western New York Conditions.

MacLeod and Howatt (6) state that mercuric and mercurous chloride applied in dry form at the rate of 10 to 15 pounds per acre can be depended upon to control common scab of the potato in heavily infested soils. Applications made in combination with fertilizer were not so effective as when the chemicals were introduced into the soil alone or with diluents.

[1]Reference is to "Literature Cited," page 19.

Cunningham (3) in a preliminary report states that both yellow oxide of mercury and calomel when added to the fertilizer mixture reduced the percentage of scab under Long Island conditions.

Blodgett and Howe (1) reporting on a survey made in New York State give some interesting data with reference to the relation of soil reaction to potato scab. Potatoes on soils from pH 4.3 to 5.4 had the least scab. The most scab was found on soils from pH 5.45 to 7.4 while there was a decrease in the amount of scab on soils from pH 7.4 to 8.5 as compared with soils from pH 5.45 to 7.4. Later work by Blodgett and Cowan (2) confirms these reports and gives further evidence that increasing the soil reaction to above pH 7.4 may actually reduce the amount of scab.

The reports are conflicting as to the value of the addition of mercury compounds to the fertilizer mixture as a means of controlling potato scab. The effectiveness of this treatment apparently varies with soil conditions and the results presented in this paper may only be applicable to Long Island conditions and possibly only to the type of soil used in the experiment.[2]

EFFECT OF ADDING MERCURY COMPOUNDS TO THE FERTILIZER MIXTURE

METHODS

The work covering this phase of the problem was carried on for a period of four years (1934–37). The following year (1938) the same area was planted to potatoes using the same fertilizer mixture but without the addition of mercury.

The mercury compounds used were yellow oxide of mercury and calomel. Each of these was used at three concentrations, namely, 2, 4, and 6 pounds per ton of fertilizer or an equivalent amount per acre.[3]

The soil was a Sassafras loam having a sandy subsoil and with a reaction of pH 4.88 to 6.08. The higher pH readings were on the area on which calomel was used, while the lower pH readings were, for the most part, on the area treated with yellow oxide of mercury. Scab infestation was as uniform as could be expected thruout the area under the experiment. The experiment was laid out in two-row plats and all treatments and checks were replicated four times. The

[2]The authors are indebted to W. C. Jacob for assistance in the statistical analysis.

[3]Altho the two materials were used in equal amounts, the authors are fully aware that yellow oxide of mercury contains 8 per cent more metallic mercury than does calomel. Furthermore, yellow oxide has somewhat finer particles and is somewhat more soluble than is calomel. These factors may account for the better results obtained with yellow oxide, but we have no evidence to support such an assumption.

rows were 214 feet long. One half of each row was planted to Irish Cobblers and the other half to Green Mountains.

The fertilizer used was a 5–8–5 mixture, approximately neutral in reaction. This was mixed by hand and at the time of mixing the necessary amounts of the mercury compounds were added. No difficulty was experienced in obtaining a good distribution of the mercury.

A potato planter from which the planting mechanism had been removed was used in applying the fertilizer. The fertilizer was placed in two bands, one on either side of the seed piece and slightly below that level. The application was at the rate of 1 ton per acre. Seed pieces were dropped by hand using a 15-inch spacing and were covered with a disc hiller.

At harvesting time data were taken on 100 feet of row for each variety. The tubers from each plat row were run over a hand grader the screen of which was slightly smaller than that required for a U. S. No. 1 grade. Scab records were taken only on tubers which passed over the grader and these were sorted into four groups according to the following arbitrary classification.

Clean = Free from scab
Slight = 1 to 5 scab spots
Medium = 6 to 15 scab spots
Severe = More than 15 scab spots.

In all groups allowance had to be made for size of tuber and size of scab spots. For instance a small tuber having four or five scab spots covering half the area of the tuber was obviously severely scabbed.

Data were taken on each group both by weight and by count. Both sets of data showed the same trend and varied but slightly. The figures given in this paper are based on weight.

STATISTICAL ANALYSIS

Separate analyses were made in all cases for both yellow oxide of mercury and calomel. Since the tubers were classified into four groups, the data were first analyzed on the basis of these groups. The three scabby groups were then combined to form a total scabby group and these data analyzed. Since the slightly scabby tubers are marketable under ordinary market conditions, this group was combined with the clean group to form a marketable group. The medium and severe groups were combined to make an unmarketable group and these data analyzed. In order to make a comparison of the value of the two mercury compounds in the control of scab, the data for yellow oxide of mercury were combined with that for calomel and analyzed on the basis of total scab.

A further analysis was made on the yield data for marketable tubers in bushels per acre. Marketable tubers in this sense refers to the size of tubers regardless of scab infestation and is based on all tubers which passed over the grader.

With the exception of yields all data were expressed on a percentage basis in order to make the years comparable. Fisher's (4) analysis of variance with Snedecor's (7) "F" value was used. Each mean is presented with its standard error which was calculated by the formula:

$$\text{S.E. of mean of n} = \frac{\text{Standard error of single}}{\sqrt{n}}$$

Differences are judged significant if they are twice their standard error. The standard error of a difference is calculated by the formula:

$$\text{S.E. A–B} = \sqrt{(\text{S.E.}_A)^2 + (\text{S.E.}_B)^2}$$

RESULTS

The results of analysis of the data on yellow oxide of mercury on the basis of four tuber classifications, together with the total scabby, are given in Table 1.

Dealing first with the four groups, the figures given in Table 1 indicate that differences due to treatment are significant under all four groupings.

The addition of 2 pounds of yellow oxide of mercury to the fertilizer mixture resulted in an increase of 17.62 per cent in the yield of clean tubers as compared to no yellow oxide. When the amount of yellow oxide was increased to 4 pounds per ton of fertilizer, the yield of clean tubers was increased by 25.03 per cent as compared with the untreated plat. The yield of clean tubers as compared with the check was increased by 28.22 per cent when the amount of yellow oxide was increased to 6 pounds. This increase was 10.60 per cent higher than that obtained by the use of 2 pounds of yellow oxide.

The use of 2 pounds of yellow oxide of mercury gave a significant reduction in the percentage of scab in the severe and medium groups but not in the slight group. The higher amounts of yellow oxide used gave a significant reduction in the percentage of scab in all three groups as compared with the untreated plats.

On the basis of total scab, all treatments with yellow oxide gave a significant reduction in the percentage of scabby tubers as compared with no treatment. The use of 4 pounds of yellow oxide did not give a significant decrease in scab as compared with the 2-pound application, but when the amount was increased to 6 pounds there was a significant reduction in percentage of scab.

TABLE 1.—PERCENTAGE OF TUBERS FALLING INTO CLASSIFIED SCAB GROUPS UNDER YELLOW OXIDE OF MERCURY TREATMENT.

	Clean	Slight	Medium	Severe	Total scabby
Treatment					
Not treated	43.58±2.66	30.51±1.78	13.50±0.90	12.41±1.10	56.42±3.01
2 lbs.	61.20±2.66	27.93±1.78	6.77±0.90	4.11±1.10	38.80±3.01
4 lbs.	68.61±2.66	23.52±1.78	4.62±0.90	3.23±1.10	31.39±3.01
6 lbs.	71.80±2.66	22.31±1.78	4.06±0.90	1.83±1.10	28.20±3.01
Years					
1934	66.49±2.66	21.37±1.78	7.60±0.90	4.54±1.10	33.51±3.01
1935	74.99±2.66	18.97±1.78	3.60±0.90	2.44±1.10	25.01±3.01
1936	59.12±2.66	29.69±1.78	6.86±0.90	4.33±1.10	40.88±3.01
1937	44.61±2.66	34.24±1.78	10.89±0.90	10.26±1.10	55.39±3.01
Varieties					
Irish Cobblers	66.78±1.88	23.23±1.26	5.96±0.64	4.03±0.80	33.22±2.13
Green Mountains	55.82±1.88	28.91±1.26	8.52±0.64	6.75±0.80	44.18±2.13

The results of analysis of the data on calomel on the basis of four tuber classifications, together with the total scabby, are given in Table 2.

The results obtained by the use of calomel in the fertilizer mixture show the same general trend as those obtained with yellow oxide of mercury. The addition of 2 pounds of calomel gave an increase of 14.68 per cent in the yield of clean tubers. Increasing the amount of calomel to 4 pounds per ton of fertilizer resulted in an increase of 25.20 per cent in the clean tubers as compared with the untreated plats. When the amount was raised to 6 pounds per ton, there was an increase of only 23.69 per cent clean tubers as compared with the check. All of these increases are significant. The use of both 4 and 6 pounds of calomel gave a significant increase in the percentage of clean tubers as compared with the 2-pound application. This increase in clean tubers is shown in a reduction in the percentage of scabby tubers in the slight and medium groups where either 2 or 4 pounds of calomel were used. When 6 pounds of calomel were used, there was a tendency for the amount of scab to be increased in these two groups. In the severe group there was a reduction in the percentage scab at all three applications, but the figures are significant only where 2 pounds of calomel were used.

On the basis of total scab all treatments with calomel gave a significant reduction in the percentage of scabby tubers as compared with no treatment. Both 4 and 6 pounds of calomel were more effective in reducing scab than were 2 pounds, but there was no significant difference between the 4- and 6-pound applications.

Since the slightly scabby tubers are marketable under ordinary market conditions, the data were also analyzed on the basis of marketable and unmarketable tubers. The results of this analysis are presented in Table 3.

The figures given in the above table show the same general trend as those given in Tables 1 and 2. The addition of 2 pounds of yellow oxide of mercury to the fertilizer mixture gave an increase of 15.08 per cent marketable tubers and of calomel an increase of 9.42 per cent over no treatment. Larger amounts of either of these compounds gave a slightly higher percentage of marketable tubers, but the differences are not significant except when compared with no treatment.

In order to obtain some idea of the comparative value of yellow oxide of mercury and calomel in controlling potato scab, the data

TABLE 2.—PERCENTAGE OF TUBERS FALLING INTO CLASSIFIED SCAB GROUPS UNDER CALOMEL TREATMENT.

	Clean	Slight	Medium	Severe	Total scabby
			Treatment		
Not treated	23.69±2.85	43.17±1.21	17.43±1.04	15.72±1.78	76.31±2.86
2 lbs.	38.37±2.85	37.91±1.21	13.16±1.04	10.56±1.78	61.63±2.86
4 lbs.	48.89±2.85	29.54±1.21	9.23±1.04	12.34±1.78	51.11±2.86
6 lbs.	47.38±2.85	31.49±1.21	9.66±1.04	11.36±1.78	52.62±2.86
			Years		
1934	50.42±2.85	34.01±1.21	10.48±1.04	5.09±1.78	49.58±2.86
1935	48.47±2.85	34.70±1.21	10.88±1.04	5.95±1.78	51.53±2.86
1936	33.56±2.85	38.89±1.21	14.94±1.04	12.61±1.78	66.44±2.86
1937	25.88±2.85	34.52±1.21	13.18±1.04	26.42±1.78	74.12±2.86
			Varieties		
Irish Cobblers	42.73±2.02	35.20±0.86	11.10±0.73	10.97±1.26	57.27±2.02
Green Mountains	36.44±2.02	35.86±0.86	13.64±0.73	14.06±1.26	63.56±2.02

TABLE 3.—PERCENTAGE OF TUBERS CLASSIFIED AS MARKETABLE AND UNMARKETABLE

	Marketable	Unmarketable
Yellow Oxide		
Not treated	74.10±1.59	25.90±1.79
2 lbs.	89.12±1.59	10.88±1.79
4 lbs.	92.17±1.59	7.83±1.79
6 lbs.	94.11±1.59	5.89±1.79
Calomel		
Not treated	66.86±2.52	33.14±2.52
2 lbs.	76.28±2.52	23.72±2.52
4 lbs.	78.43±2.52	21.57±2.52
6 lbs.	78.88±2.52	21.12±2.52

for clean tubers by both treatments were grouped together and analyzed as a whole. The results of this analysis are given in Table 4.

TABLE 4.—COMPARISON OF YELLOW OXIDE AND CALOMEL TREATMENTS FOR CONTROL OF SCAB.

Treatment	Clean
Not treated	33.97±2.67
Yellow Oxide, 2 lbs.	61.19±2.67
Calomel, 2 lbs.	38.37±2.67
Yellow Oxide, 4 lbs.	68.63±2.67
Calomel, 4 lbs.	48.89±2.67
Yellow Oxide, 6 lbs.	71.81±2.67
Calomel, 6 lbs.	47.38±2.67

On the basis of this analysis, yellow oxide of mercury gave a significantly higher percentage of clean tubers at 2, 4, and 6 pounds per ton of fertilizer than did calomel at the same amounts, when compared with the untreated plats. The highest percentage increase over the untreated plats with the calomel treatment was obtained at the 4-pound per ton application, but this increase was significantly lower than that obtained with 2 pounds of yellow oxide of mercury.

In 1938 the same areas were planted to potatoes, but the mercury was omitted from the fertilizer mixture. This was done with the idea of getting data with reference to the possible residual effect of the mercury. These data were analyzed and the results are presented in Table 5.

The figures given in the above table show very clearly the uniformity of the scab infestation on the area of land used in this

TABLE 5.—PERCENTAGE OF TUBERS FALLING INTO CLASSIFIED SCAB GROUPS AFTER 4 YEARS' TREATMENT WITH YELLOW OXIDE OF MERCURY AND CALOMEL

	Clean	Slight	Medium	Severe
		Yellow Oxide		
Not treated	35.69±5.55	37.50±3.76	10.64±1.59	16.17±3.54
2 lbs.	37.12±5.55	37.70±3.76	10.46±1.59	14.72±3.54
4 lbs.	32.95±5.55	38.41±3.76	11.38±1.59	17.26±3.54
6 lbs.	34.08±5.55	38.62±3.76	12.84±1.59	14.46±3.54
Irish Cobblers	54.84±3.93	38.90±2.66	4.93±1.12	1.33±2.50
Green Mountains	15.06±3.93	37.20±2.66	17.72±1.12	59.92±2.50
		Calomel		
Not treated	25.10±4.07	38.80±3.65	15.01±1.62	21.09±4.34
2 lbs.	29.58±4.07	40.33±3.65	10.29±1.62	19.80±4.34
4 lbs.	24.66±4.07	39.66±3.65	13.87±1.62	21.81±4.34
6 lbs.	17.74±4.07	44.05±3.65	17.98±1.62	20.23±4.34
Irish Cobblers	40.55±2.88	43.63±2.58	9.43±1.15	6.39±3.07
Green Mountains	7.99±2.88	37.79±2.58	19.16±1.15	35.06±3.07

experiment. For the sake of comparison the table is arranged in the same way as is Table I, but actually no mercury was applied in 1938. There is no significant difference between the untreated plats and plats treated with mercury for the four years (1934–37). It is clearly evident that there is no accumulative or residual effect from the addition of either of the mercury compounds to the fertilizer mixture in so far as the control of scab is concerned.

The figures presented in Tables 1 and 2 with reference to years are interesting in bringing out the severity of the scab infestation in the various years and the scab groups into which the tubers were sorted.

On the area treated with yellow oxide of mercury the percentage of scabby tubers was significantly higher in 1937 than in the other three years. This was true of all of the scab groups. In 1936 the slight and medium groups contained a significantly higher percentage of tubers than the same groups in 1935, but there was no significant difference in the severe infection in these two years. In 1935 all three groups had a slightly lower percentage of tubers than in 1934, but it is only in the medium group that the figures are significant.

On the area treated with calomel there was more scab in 1937 than in 1936, but the figures are significant only for the severe group. There was more scab in 1936 than in 1935 and the differences are significant in all of the groups. There is no significant difference

between the percentage of scab in 1935 and 1934 in any of the groups.

The figures given in Tables 1, 2, and 5 indicate that Green Mountain is more severely injured by scab than is Irish Cobbler. The differences are highly significant in the medium and severe groups or those which may be classed as unmarketable.

Analysis of the data for interactions between treatment by years, treatment by variety, and variety by years did not show any significant differences.

The effect of treatment on yield is of importance and in order to determine this the data on yields of marketable tubers in bushels per acre were analyzed. The results are shown in Table 6. Marketable tubers in this case are the tubers which passed over the grader regardless of scab infestation.

TABLE 6.—BUSHELS PER ACRE OF MARKETABLE TUBERS BY GRADE AFTER TREATMENT WITH YELLOW OXIDE OF MERCURY OR CALOMEL.

Treatment	Bushels per acre
Not treated	256.94±4.07
Yellow Oxide, 2 lbs.	267.97±4.07
Yellow Oxide, 4 lbs.	275.96±4.07
Yellow Oxide, 6 lbs.	264.58±4.07
Not treated	244.74±3.17
Calomel, 2 lbs.	256.12±3.17
Calomel, 4 lbs.	245.26±3.17
Calomel, 6 lbs.	246.15±3.17

The figures given in Table 6 show that where yellow oxide of mercury was used the yields were heavier than on the untreated plats but only where 4 pounds were used is the difference significant. Increasing the application to 6 pounds per ton of fertilizer resulted in a significant decrease in yield over the 4-pound application. Calomel also increased yields but only at the 2-pound rate is the difference significant. Applications of 4 and 6 pounds resulted in significant decreases in yields when compared with 2 pounds.

DISCUSSION

Under the conditions of this experiment the results show that either yellow oxide of mercury or calomel may be used to advantage in the fertilizer mixture in controlling common scab of the potato.

From the standpoint of the production of clean tubers it is pos-

sible to use yellow oxide of mercury at the rate of 6 pounds per ton of fertilizer, but this amount is very little better than 4 pounds in increasing the percentage of clean tubers. In addition to the added cost there is the possibility that the higher amount may result in decreased yields.

Calomel may be used at the rate of 4 pounds per ton of fertilizer from the standpoint of production of clean tubers, but there is no advantage in going above this amount. The yields may be reduced if more than 2 pounds is used.

On the basis of marketable tubers, including slightly scabby tubers, there seems to be little advantage in using more than 2 pounds per ton of fertilizer of either yellow oxide of mercury or calomel.

The work done in 1938 shows very clearly that there is no accumulative or residual effect of the mercury in controlling potato scab. Applications must be made each year to be effective.

The amount of scab infestation varied with the different years. Scab infestation depends upon a number of factors. Among these are the temperature and moisture content of the soil and these vary with the season.

Thruout the period of the experiment Green Mountain potatoes were more severely affected with scab than were Irish Cobblers.

RELATION OF SOIL REACTION TO FERTILIZER-MERCURY COMBINATIONS

METHODS

The type of soil, method of planting, and fertilizer used in this experiment were similar to those described in the first part of this paper. Only the variety Green Mountain was used in this part of the work. The experiment was laid out on permanent soil reaction plats which were established as early as 1924. One row in each plat was treated with yellow oxide of mercury and one row with calomel, each being mixed with the fertilizer at the rate of 4 pounds per ton. The adjacent row in either case was used as a check, the fertilizer on these rows having no mercury added. The pH determinations were made about the time tubers were beginning to form.

STATISTICAL ANALYSIS

The block of land was divided into 65 plats having soil reactions varying from pH 4.5 to 7.0. Since one row in each plat was treated with yellow oxide of mercury and one with calomel and since the adjacent rows were used as checks, there was a total of 260 treat-

ment plats. These were classed in pH ranges of 0.25 units and the data analyzed on that basis.

By preliminary analysis it was found that these pH ranges responded differently to the treatment and because of these differences could be divided into three groups as follows:

Lower group = pH 4.51–5.00
Medium group = pH 5.01–6.00
Upper group = pH 6.01–7.00

The medium group may be considered as being the critical point in the pH range in relation to scab infestation. Somewhere within this range lies the point at which there is a marked increase in the amount of scab. Since these groups were so widely different in response it was deemed necessary to deal with each separately. For this reason the data were analyzed in three lots covering the ranges given above.

At harvest time the potatoes were graded and the tubers of marketable size were divided into four classes, *viz.*, clean, slight, medium, and severely scabbed. The data were divided into classes according to the pH groupings and each class analyzed separately. The scabby classes were then combined and the data analyzed on the basis of total scabby. A further classification was made by combining the clean and slight as being marketable and the severe and medium as being unmarketable. The data were again analyzed on this basis.

Because of the extreme variability of the number of frequencies in the various groups, the modification of analysis of variance suggested by Yates (11) was used. Snedecor's (8) test of significance was used and the 5 per cent point or odds of 19:1 were considered as being significant.

Each mean is presented with its standard error and to be significant any difference must be at least twice the standard error of that difference. The formula for calculating the standard error of a difference is given in the first part of this paper.

All data were put on a percentage basis to make the various years and plats comparable.

RESULTS

In Table 7 are presented the results of the analysis of the three pH groups on the basis of classification with reference to scab infection.

The table presents an interesting picture with reference to the severity of scab infestation within the pH groups. Considering the check plats only, it will be found that there were approximately 19 per cent scabby tubers in the 4.51–5.00 pH group and of the total number of scabby tubers about 13 per cent were classed as slightly scabby. In the 5.01–6.00 pH group there were approximately 63 per cent scabby tubers and of this total 37 per cent were classed as being

TABLE 7.—PERCENTAGE SEVERITY OF SCAB INFECTION AS RELATED TO TREATMENT AND SOIL REACTION.

Treatment	Clean	Slight	Medium	Severe	Total scabby
		4.51–5.00 pH			
Not treated	81.14±2.47	13.20±1.03	2.94±0.46	2.72±1.10	18.86±0.70
Yellow Oxide, 4 lbs.	93.36±3.57	4.64±1.50	0.15±0.67	1.89±1.60	6.64±1.01
Calomel, 4 lbs.	91.82±3.76	4.39±1.58	0.84±0.70	2.95±1.68	8.18±1.06
		5.01–6.00 pH			
Not treated	36.66±1.55	16.98±0.82	9.29±0.55	37.07±1.51	63.34±1.45
Yellow Oxide, 4 lbs.	47.41±2.25	15.65±1.20	7.71±0.80	29.23±2.20	52.59±2.10
Calomel, 4 lbs.	47.08±2.17	15.66±1.15	8.01±0.77	29.25±2.11	52.92±2.02
		6.01–7.00 pH			
Not treated	2.46±1.48	1.10±0.40	3.21±0.75	93.23±3.11	97.54±1.47
Yellow Oxide, 4 lbs.	1.39±1.93	9.22±0.52	11.23±0.98	78.14±4.04	98.61±1.91
Calomel, 4 lbs.	3.77±2.07	5.18±0.56	7.92±1.05	83.13±4.34	96.23±2.05

severely scabbed. In the 6.01–7.00 pH group, with a total of 97 per cent scabby tubers, 93 per cent were classed as being severely scabbed.

Further study of these figures shows that in the lower pH group both yellow oxide of mercury and calomel gave significant reductions in the percentage of scabby tubers in the slight and medium classes but did not significantly reduce the percentage of those severely scabbed. These reductions resulted in increasing the percentage of clean tubers by over 12 per cent when yellow oxide was used and in the case of calomel by nearly 11 per cent. There was no significant difference between the treatments.

In the medium group the percentage of scabby tubers in all three classes was reduced as a result of treatment, but it is only in the severely scabbed class that the figures are significant. As in the case of the lower pH group the reduction in scab was sufficient to increase the percentage of clean tubers by over 10 per cent in both the yellow oxide of mercury and calomel treatments.

The higher pH group presents a different picture. Both yellow oxide of mercury and calomel caused a significant reduction in the percentage of tubers classed as being severely scabbed as compared with the check, but the treatments were not significantly different in themselves. The reduction of scab in the severe class was not reflected by a significant increase in the percentage of clean tubers but was reflected by a significant increase in the percentage of tubers falling into the slight and medium classes and this increase was significantly greater with yellow oxide of mercury than with calomel.

Both yellow oxide of mercury and calomel gave a significant reduction in the total percentage of scabby tubers in the two groups covering the pH range from 4.51–6.00 as compared with the untreated plats, but there was no significant difference between the treatments.

The results with reference to marketable and unmarketable tubers are given in Table 8.

In the lower pH group the addition of mercury to the fertilizer did not significantly reduce the percentage of unmarketable tubers as compared with the check. In the other two groups both of the mercury compounds gave significant reductions in the percentage of unmarketable tubers.

The influence of the soil reaction on the percentage of scabby tubers is shown in Table 9.

TABLE 8.—EFFECT OF TREATMENT AND SOIL REACTION ON THE PERCENTAGE OF MARKETABLE TUBERS.

Treatment	Marketable	Unmarketable
4.51–5.00 pH		
Not treated	94.35±1.38	5.66±1.43
Yellow Oxide, 4 lbs.	97.97±2.00	2.03±2.07
Calomel, 4 lbs.	96.22±2.10	3.78±2.17
5.01–6.00 pH		
Not treated	53.62±1.55	46.38±1.56
Yellow Oxide, 4 lbs.	63.05±2.24	36.95±2.25
Calomel, 4 lbs.	62.80±2.17	37.20±2.17
6.01–7.00 pH		
Not treated	3.55±1.88	96.45±1.35
Yellow Oxide, 4 lbs.	10.66±2.44	89.34±1.75
Calomel, 4 lbs.	8.95±2.62	91.05±1.88

TABLE 9.—INFLUENCE OF SOIL REACTION ON THE PERCENTAGE OF SCABBY TUBERS

pH range	Clean	Slight	Medium	Severe	Total scabby
4.51–4.75	91.75±4.45	5.50±1.87	0.99±0.83	1.76±1.98	8.25±1.26
4.76–5.00	86.62±1.95	9.76±0.82	1.93±0.26	2.69±0.87	14.38±0.55
5.01–5.25	77.78±1.91	13.06±1.01	3.47±0.68	5.69±1.85	22.22±1.79
5.26–5.50	41.13±2.09	23.83±1.10	9.02±0.74	26.02±2.03	58.87±1.95
5.51–5.75	19.20±2.70	18.13±1.42	13.61±0.96	49.06±2.62	80.80±2.52
5.76–6.00	7.05±2.32	10.57±1.22	11.81±0.82	70.57±2.25	92.95±2.16
6.01–6.25	2.35±1.57	6.06±0.43	8.56±0.80	83.03±3.30	97.65±1.56
6.26–6.50	4.18±1.74	3.80±0.47	5.97±0.89	86.05±3.67	95.82±1.73
6.51–6.75	0.10±2.51	2.97±0.68	4.60±1.28	92.53±5.28	99.90±2.50
6.76–7.00	0.60±3.77	0.93±1.03	2.98±1.92	95.49±7.92	99.40±3.75

The figures given in Table 9 show very clearly the influence of soil reaction on the percentage of scabby tubers. On the basis of total scab and within the pH range from 5.25 to 6.01, there is a noticeable increase in the percentage of scabby tubers as the pH rises. A very sharp increase in the percentage of scab occurs at the pH range 5.26 to 5.50. This increase amounts to over 36 per cent and at the next higher pH range there is an additional increase of nearly 22 per cent. From these figures it seems that within the pH range 5.26 to 5.50 lies the critical point at which the soil reaction becomes a serious factor in scab infestation. A more detailed analysis of this range shows that a large part of this increase in scab within this group takes place at pH 5.31 to 5.35. In the slight group the per-

centage of scab increases gradually as the pH increases until it reaches its maximum at pH 5.26 to 5.50 after which the percentage declines. The same is true of the medium group, but here the maximum is reached at pH 5.51 to 5.75. In the severe group the percentage of scab increases markedly between pH 5.26 and 6.00. This increase amounts to over 20 per cent for each 0.25 pH unit within this range.

Since in the pH group 5.01 to 6.00 lies the critical point at which the percentage of scabby tubers increases rapidly, it is important to obtain some idea of the relation of treatment to soil reaction within this range. The analysis showed that there were significant differences in treatment by pH within this group. The results of this analysis on the basis of total scabby tubers is given in Table 10.

TABLE 10.—RELATION OF TREATMENT TO SOIL REACTION IN THE CONTROL OF SCAB.

Treatment	Soil reaction			
	5.01–5.25 pH	5.26–5.50 pH	5.51–5.75 pH	5.76–6.00 pH
Not treated.....	28.20±2.51	69.35±2.80	84.15±3.40	91.99±3.10
Yellow Oxide, 4 lbs....	17.11±3.60	47.02±4.09	75.39±5.23	93.96±4.30
Calomel, 4 lbs.....	15.21±3.56	50.55±3.65	78.12±5.37	93.77±4.23

The addition of either yellow oxide of mercury or calomel to the fertilizer mixture resulted in a significant decrease in the percentage of scabby tubers within the pH range 5.01 to 5.50. Above that range any reduction in scab is comparatively small and the differences are not significant. While at the pH range 5.26 to 5.50 there is a significant difference due to either yellow oxide of mercury or calomel, the scab infestation is so high at this range that the treatment has little or no commercial value.

DISCUSSION

The fact that soil reaction is an important factor in the severity of potato scab infestation has long been recognized and the evidence presented here is in keeping with the findings of other workers. It is evident from the data presented in this paper that the higher the soil reaction, the greater is the total percentage scabby tubers and the higher the percentage of this total which may be classed as severely scabbed.

Under the conditions of this experiment the use of either yellow oxide of mercury or calomel at the rate of 4 pounds per ton of fertilizer (equivalent to the same amount per acre) is effective in decreasing the amount of scab within the pH range 4.51 to 6.00.

The severity of scab infestation increases rapidly in the pH range 5.26 to 5.50 and more detailed analysis of this range indicated that a large part of this increase took place in the range 5.31 to 5.35. When the soil reaction goes above that point the mercury treatment will reduce the percentage of scabby tubers but has little or no commercial value.

Just how soil reaction affects the treatment has not been determined. It may be that when the soil reaction is high the mercury is less effective not only because of some action on the mercury itself, but also because of the virulence of the scab organism in the higher pH brackets. Whatever may be the reason, the addition of mercury compounds to the fertilizer mixture for the control of potato scab can not be recommended for soils having a high pH reading.

CONCLUSIONS

Under Long Island conditions, 4 pounds of either yellow oxide of mercury or of calomel added to each ton of the fertilizer mixture will reduce the amount of potato scab on soils having a reaction of pH 5.50 or below. Larger amounts of these mercury compounds are no more effective in controlling scab and may result in decreased yields.

Yellow oxide of mercury is more effective than calomel in the control of scab.

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